Temperature and Humidity Effects on Survival of Chickens

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Wilson and Armas (1963) found that with a relative humidity of 75 per cent, the survival time of four-week old White Leghorn chicks decreased sharply as the temperature was increased from 40.5C to 48.8C. Lee et al. (1945) observed that under natural conditions relative humidity was an important factor in the tolerance of laying hens to temperatures of 40.5C or greater. However, very little is known concerning the exact relationships between temperature and relative humidity (R.H.) when both were at high levels.

The following experiment was designed to determine the effects of temperature, humidity, and air flow rate on the survival time of five-week old White Leghorn chicks.

Procedure

Two experiments were conducted with five-week old White Leghorn chicks obtained from nine hatches. The chicks were pedigree hatched from the F_1 generations of two genetic lines which had been previously selected for a high and a low heat tolerance (Wilson et al., 1966). Chicks were brooded in floor pens with infra-red lamps as a heat source and were given water and commercial type starter feed ad libitum.

The heat cabinet used was the same as that described by Ross and Myers (1963) with the modifications listed by Wilson et al. (1966). The temperature inside the chamber was controlled within ±0.2C, the R.H. within ±2.5 per cent and the air flow rate within ±0.1416 cubic meters (m^3) per minute. The chamber temperature dropped approximately 1.94C while the chicks were being placed in the chamber, but it recovered to approximately 0.4C of the desired temperature within three minutes after the start of the test. The unit fully recovered within ten minutes after the start of the test.

Temperatures of 40.5, 42.2, and 43.9C were used with 60, 75, and 90 per cent R.H. and air flow rates of 1.1327, 1.6990, and 2.2653 m^3 per minute, resulting in 27 different environmental treatments. Since only one heat cabinet was available it was impossible to run 27 treatments per day. Therefore, nine different hatches were made on different days to facilitate the use of chicks when they were exactly five weeks of age. The same procedure was used for the second experiment. A specially designed wire cage with 30 individual compartments was used to keep the birds separated and facilitate the maintenance of individual records. Thirty chicks were equalized according to genetic line and sex in each environmental treatment.

The survival time of individual chicks was measured in seconds from time of placement in the chamber (Wilson et al., 1966) and converted to minutes and tenths of minutes for analysis. The data of both experiments were combined and subjected to analysis of variance according to the procedure of Snedecor (1956).

RESULTS AND DISCUSSION

A significant difference ($P<.01$) was found in survival times between the two genetic lines with the lo-line chicks surviving an average of 72.4 minutes and the hi-lines an average of 99.9 minutes. The survival time of the males was 81.8 minutes and the females 86.0 minutes. None of the interactions involving genetic lines or sex were significant. Therefore, lines and sexes were combined for this presentation.

Both temperature and humidity significantly ($P<.01$) affected survival times (Table 1). Each time the temperature was increased, survival time was decreased. Survival time was decreased significantly when the R.H. was increased from 60 to 75 per cent, and the decrease approached significance when the R.H. was increased from 75 to 90 per cent. The effect on survival time of increasing the R.H. from 60 to 75 per cent was similar to that observed by Yeates et al. (1941) on body temperature when the R.H. was increased from 65 to 75 per cent. Apparently, temperature had a greater effect on survival time than humidity within the ranges studied.

The temperature $\times$ humidity interaction was found to be significant ($P<.01$) indicating the extent to which temperature affects survival time is dependent upon the humidity and vice versa. Survival time was shortened more when R.H. was increased from 60 to 75 per cent than from 75 to 90 per cent in both absolute terms and on a percentage change basis (31.4 vs. 15.5 per cent

TABLE 1
Survival times of chicks as influenced by temperature, relative humidity and air flow rates

R.H. (%)	Air Flow (m^3)	Survival time (min.)[1] Temperature 40.5C	42.2C	43.9C	Average
60	1.1327	204.9[2]	102.4	47.5	118.3
	1.6990	199.1	100.4	49.3	116.3
	2.2653	162.8	90.5	48.2	100.5
Av.		188.9	97.8	48.3	111.7[a]
75	1.1327	117.0	57.5	43.7	72.7
	1.6990	129.9	64.1	39.0	77.7
	2.2653	141.4	58.1	41.6	80.4
Av.		129.5	59.9	41.4	76.9[b]
90	1.1327	107.2	44.4	32.5	61.4
	1.6990	109.9	44.4	33.9	62.7
	2.2653	111.0	52.0	31.9	65.0
Av.		109.4	46.9	32.8	63.0[b]
Av.	1.1327	143.1	68.1	41.2	84.1
	1.6990	146.3	69.6	40.7	85.5
	2.2653	138.4	66.8	40.6	81.9
Av.		142.6[x]	68.2[y]	40.8[z]	83.9

[1] Means with different superscripts differ significantly ($P<.01$).
[2] Each value represents the average of 60 birds.

and 38.8 vs. 21.7 per cent, respectively) at both 40.5 and 42.2C. However, at 43.9C this relationship was reversed (14.3 vs. 20.8 per cent). This demonstrates that survival time was affected more by increasing the humidity at the lower temperatures than at the higher temperatures and that increasing the R.H. from 60 to 75 per cent had a greater effect than increasing it from 75 to 90 per cent, except at the highest temperature. This might have been expected since Wilson and Edwards (1953) reported that the effect of 72 per cent R.H. on respiratory rate and body temperature was more pronounced at 37.8C than at lower temperatures.

The survival time decreased more when the temperature was increased from 40.5 to 42.2C than when it was increased from 42.2 to 43.9C in absolute terms at all humidities. However, the percentage change was approximately equal at 60 per cent R.H. (48.2

vs. 50.6 per cent) and was much higher in the 40.5 to 42.2C change than in the 42.2 to 43.9C change at 75 per cent R.H. (53.7 vs. 30.9 per cent) and at 90 per cent R.H. (57.1 vs. 30.1 per cent). Therefore, at the higher temperature and lower humidity, the effect of increasing the humidity was masked to some extent by the magnitude of the temperature effect. This may indicate that as temperature increased the critical effect of R.H. was reached at a lower point.

Air flow rates did not significantly affect the survival time of the chicks. This might have been expected since the major source of heat loss in the chick is by evaporative cooling from the lungs and in this study it was possible to maintain a constant relative humidity at all air flow rates. However, with decreased air flow rates this factor might become more important.

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Summary

Five-week old chicks from high and low heat-tolerant lines were subjected to temperatures of 40.5, 42.2, and 43.9C with 60, 75, and 90 per cent relative humidity and air flow rates of 1.1327, 1.6990, and 2.2653 cubic meters per minute. Survival times were 142.6, 68.2, and 40.8 minutes, respectively, for temperature and 111.7, 76.9, and 63.0 minutes, respectively, for relative humidity. Genetic line, temperature, and humidity were found to have significant effects on survival times of the chicks while sex and air replacement rate did not significantly affect survival times. The temperature × humidity interaction was significant.

Literature Cited

Lee, D. H. K., K. W. Robinson, N. T. M. Yeates, and M. I. R. Scott. 1945. Poultry husbandry in hot climates—Experimental enquires. Poultry Sci., vol. 24, pp. 195-207.

Ross, I. J., and J. M. Myers. 1963. Humidity, temperature and air flow control cabinets for experimentation in processing agricultural products. Paper presented at the 1963 International Symposium on Humidity and Moisture, Washington, D. C., May 20-23, 1963.

Snedecor, G. W. 1965. Statistical Methods. 5th Ed. The Iowa College Press, Ames, Iowa.

Wilson, H. R., A. E. Armas, I. J. Ross, R. W. Dorminey, and C. J. Wilcox. 1966. Familial differences of S. C. White Leghorn Chickens in tolerance to high ambient temperature. Poultry Sci., vol. 45, pp. 784-788.

Wilson, H. R., and A. E. Armas. 1963. The effect of temperature and age on susceptibility of chicks to heat. Unpublished data. Fla. Agr. Exp. Sta.

Wilson, W. O., and W. H. Edwards. 1953. Interaction of humidity and temperatures as affecting "comfort" of White Leghorn hens. Poultry Sci., vol. 32, p. 929.

Yeates, N. T. M., D. H. K. Lee, and H. J. G. Hines. 1941. Reactions of domestic fowl to hot atmospheres. Proc. Roy. Soc. Queenslands, vol. 53, pp. 105-128.

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